IRISH FISHERIES INVESTIGATIONS

SERIES A (Freshwater)

No. 14 (1974)

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CHRISTOPHER MORIARTY

STUDIES OF THE EEL *ANGUILLA ANGUILLA* IN IRELAND.
3. IN THE SHANNON CATCHMENT.

Studies of the eel *Anguilla anguilla* in Ireland.

3. In the Shannon Catchment.

by

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(Received June 12, 1974).

ABSTRACT

A sample of 1,637 immature eels of length 28 to 91 cm and age 5 to 26 years was collected in summer seasons from 1969 to 1973 by fyke netting. The growth rate was similar to that of eels in many other Irish lakes but the age at maturity in the eels of the main Shannon was several years more than in similar waters. The food was almost exclusively invertebrate. In the Fergus system lakes earlier maturity was noted and fish was the principal food of eels of over 50 cm. A preliminary study of eels migrating upstream at Parteen Weir in 1973, 15 km above the tidal boundary, showed that few, if any, elvers travelled that distance in their first year.

1. INTRODUCTION

The River Shannon, draining about one third of the area of Ireland, is the basis of the most valuable eel fishery in the Republic. Official statistics indicated that the mean annual catch for the Limerick Fishery District, which contains no other eel fisheries, in 1970-1972 amounted to 24.6t, valued at £20,101 (Anon 1974). The catches in 1906 and 1907 were at least 62 and 69t respectively (Anon 1907, 1908) and it has been felt that the present yield could be increased. Efforts to do so have been made by the principal fishery owners, the Electricity Supply Board, by overland transport and planting of elvers and small eels since 1960.

This paper describes the results of a survey of several lakes on the main Shannon made in 1969 and 1970, of lakes on the tributary Fergus system in 1968 and 1973 and of parts of the Shannon estuary in 1971 and 1972. It will be seen that most of the eels retained in the nets used in the survey were over ten years old. The 1969 and 1970 samples therefore included few or no eels which had been artificially planted. The survey should therefore provide a base line from which the effect of stocking may be determined. The study of this river system is to be continued, both by further sampling of the non-migrating stocks and by sampling of ascending elvers and small eels. A preliminary note on the latter is included in this paper.

A description of the methods used has been given by Moriarty (1972). In brief, the samples were collected by setting trains of fyke nets overnight. The unit of effort was the catch made by one net in one night. It was found that more eels entered nets set in one place on the first night than on subsequent nights. In calculating the catch per unit of effort catches made in nets which were left in position for two or more nights have therefore been ignored. This results in a slightly higher figure than that calculated in previous work. A discussion on the use of the fyke nets and the assessment of their results is in press (Moriarty 1974). Contents of the stomachs of eels from Lough Key were weighed after preservation in 70% alcohol. Surplus preservative was removed on blotting paper before weighing.

2. RESULTS

LOUGH DERG AND PARTEEN STORAGE BASIN 1969

Lough Derg (Figure 1) lies mainly in Carboniferous limestone but its southern part, in which the sampling took place, is bordered by Silurian shales. The lake has an area of 11,714 ha and measured approximately 40 km from north to south. The greatest width from east to west was 14 km but over most of its length the width varied from 2 to 5 km. The greatest depth was 34 m but a large proportion of the area, of the order of one half, was less than 10 m.

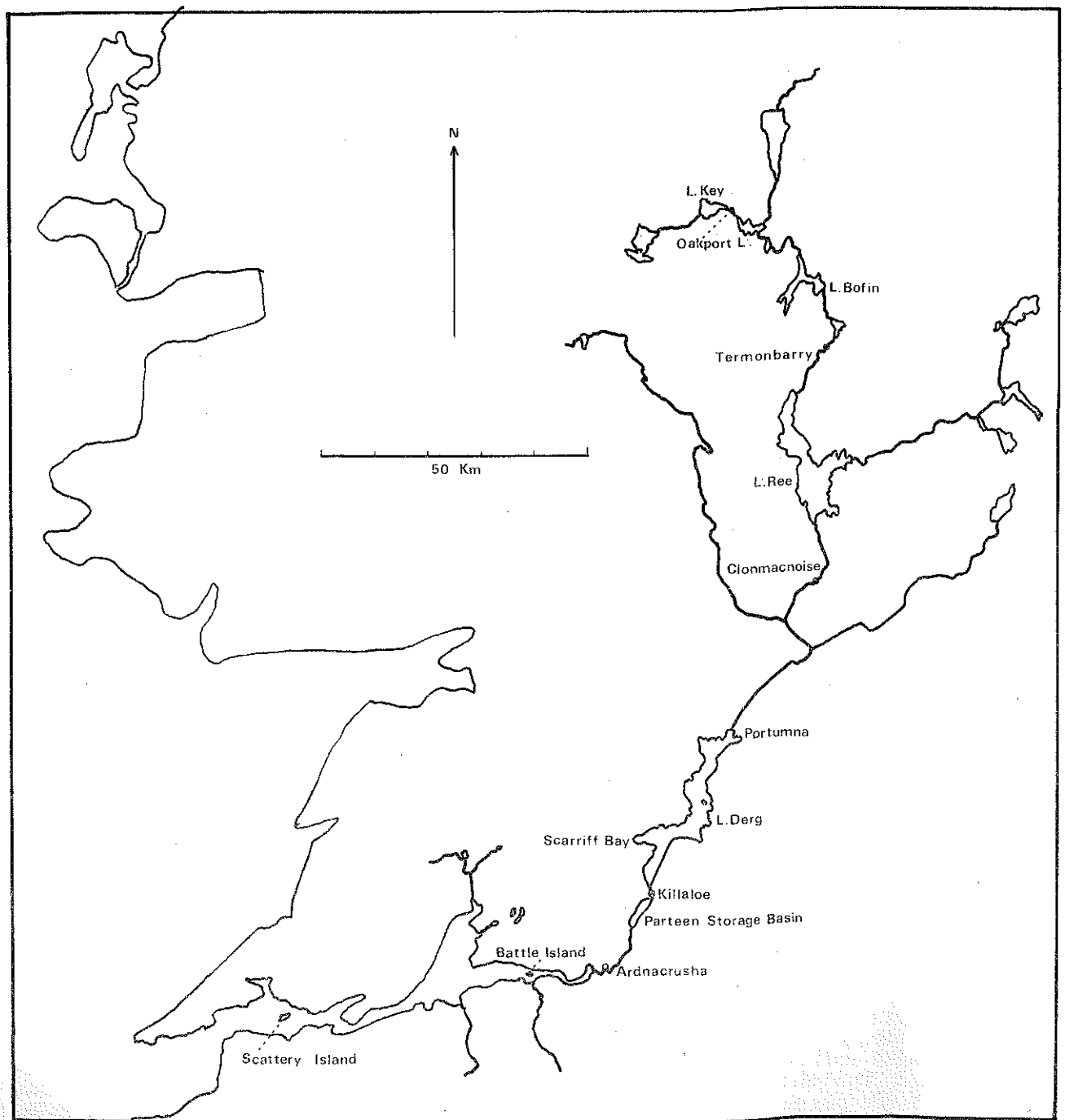

Fig. 1. The Shannon Catchment showing sampling positions. Based on the Ordnance Survey by permission of the Government (Permit No. 1833).

Lough Derg narrowed at its southern end into the River Shannon which was crossed by a bridge at Killaloe, the site of the principal fishery for silver eels. The valley downstream of Killaloe was flooded by the construction of Parteen Weir which controls the headrace canal to the generating station at Ardnacrusha. The flooded area was known as Parteen Storage Basin (Figure 2). It formed a lake of 5 km length with a surface area of 300 ha and a maximum depth of 6 m. Parteen Weir was 15 km upstream of tidal water and Lough Derg was thus 20 km from the tide. The alkalinity at Killaloe ranged from 3.4 to 3.8 (Flanagan and Toner 1972).

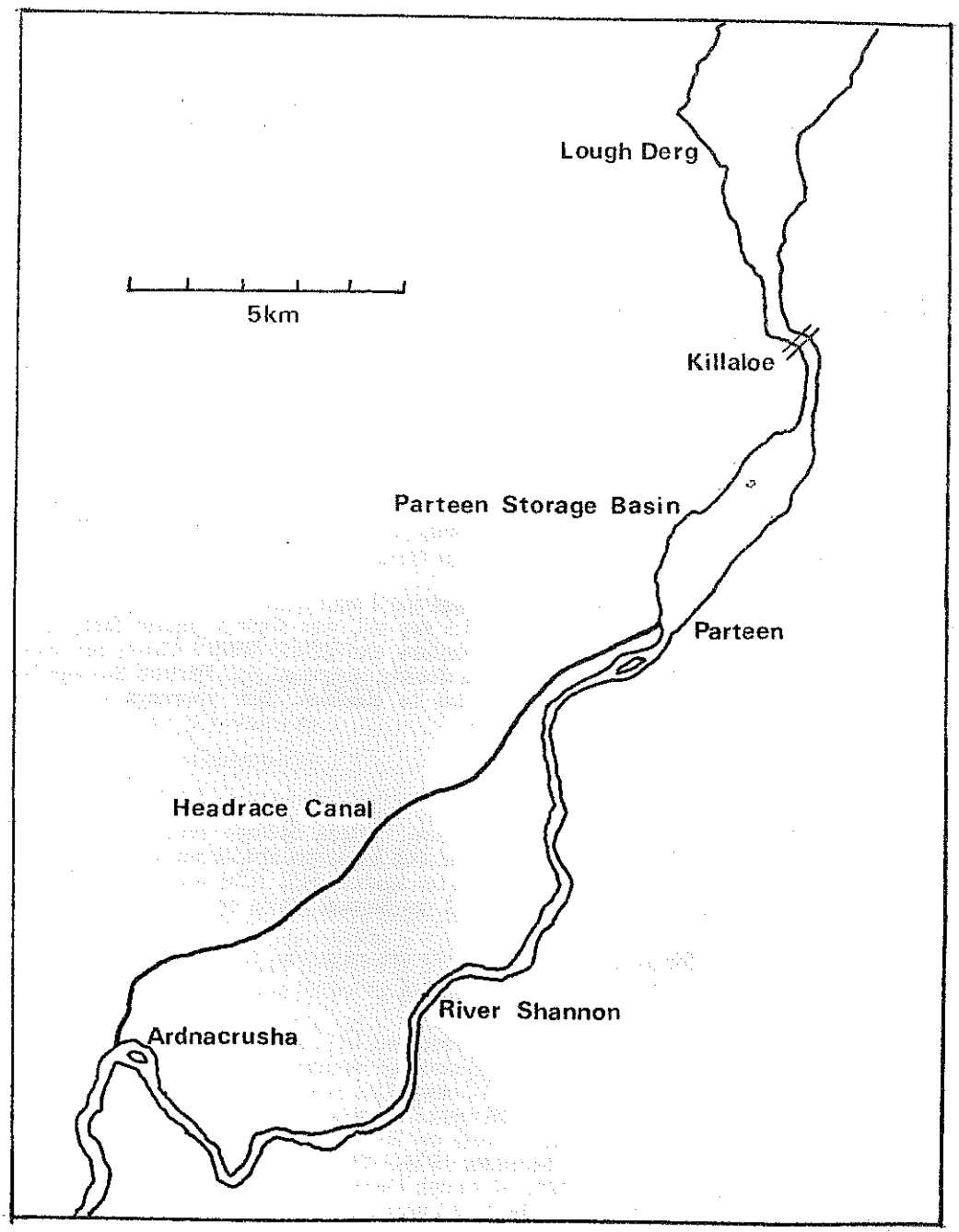

Fig. 2. The Lower Shannon. Based on the Ordnance Survey by permission of the Government (Permit No. 1833).

Elver passes were built both at Ardnacrusha dam and at Parteen Weir; the elvers reaching the latter by the main river, bypassing the headrace. Since 1960 all elvers have been trapped at the two dams and transported overland. In addition to elver movements, an upstream migration of small eels from the main river takes place at Parteen. It was found in 1973 that few or no eels in their first year from metamorphosis reached Parteen (see p.15).

The sampling season at Lough Derg in 1969 extended from July 15 to August 7, at Parteen from August 8 to August 14 and with one more day, August 15, at Lough Derg. Field work was by Mr. Dermot Douglas, zoology student, assisted by Electricity Supply Board staff. The highest temperatures recorded were 19°C in July and 18.5°C in August. Sampling in Lough Derg took place to the south or east of Scariff Bay (Grid reference R6584), covering the southern 11 km of the lake.

One train of nets was set in the River Shannon at Killaloe. Figures for the catch and effort are included in Table 2. While the catch per unit of effort was higher than the mean for Lough Derg, neither this nor any of the other observations for the river differed significantly from those for the lake.

Catch and effort

A total effort of 189 net days (number of nets x fishing nights) yielded a catch of 300 eels, 1.6 per unit of effort. The figure in Table 2, also of 1.6 was based on an effort of 77 net days in water of less than 4 m. Results from other depths are shown below:

Depth (m)	Effort	Catch	Catch per unit effort
3—15	42	59	1.4
30	6	5	0.8

While the decline in catch with depth was not statistically significant, it appeared that the population density was lower at greater depths. Catch per unit effort on a daily basis ranged from 0.4 to 2.7 for trains of seven nets.

In Parteen Storage Basin the nets were set in water between 1 and 3 m on six days and on a sloping bed from 3 to 15 m on one day. The catch in deeper water, 1.3 per net, was slightly higher than the mean of 1.1 for shallow but most of the eels had been caught in the shallow end of the train. Catch per unit effort on a daily basis ranged from 0.1 to 1.9. The lower population density suggested that Parteen Storage Basin was not an attractive habitat for the eels which consequently tended to continue their journeys upstream to Lough Derg.

Length weight and age

The lengths of 271 eels from Lough Derg and of 57 from Parteen Storage Basin are given in Table 3 While the mean lengths did not differ significantly, the number of large specimens (greater than 50 cm) in Parteen was significantly lower than in Lough Derg: 15% as against 34% (Chi square 4.73 for one degree of freedom). This supported the view that eels moved out of the Storage Basin comparatively quickly.

The length/weight regressions for specimens of over 40 cm gave the following figures in the equation $l = aw^b$

	a	b	s	n
L. Derg	0.00098	3.15	0.05	63
Parteen	0.011	2.6	0.09	46

Otoliths were prepared for reading by burning (Moriarty 1973). "Clear" otoliths, in which all rings were well defined and presumably annual, accounted for 39% of Lough Derg specimens and 55% of those from Parteen. In Lough Derg eels of 60 cm were found down to the 11-12 year group. No specimens of this size from Parteen were aged. Eels of as little as 39 cm length were found to be aged up to 16 years. Of the five specimens of 17 years and over, all were longer than 50 cm. Details of age and length are given in Table 4

Food

The rates of feeding, as judged by the presence or absence of food in the stomachs, were the same for all size groups in each water. However, the Parteen eels showed a very much higher proportion of empty stomachs than did those from Lough Derg, 74% as against 43%, a highly significant difference (Chi square = 12.1 for 1 degree of freedom). Full stomachs were very few, no more than four being recorded from the area (Table 5) The dominant food organisms in the four are shown in Table 6. They included *Bithynia, Asellus* and an unidentified fish.

Food preferences on the basis of presence or absence of the major groups showed that both populations fed largely on invertebrates. No preference for any particular type of organism was shown by eels of different sizes. No fish whatever were eaten by individuals of less than 40 cm but so few fish were present in any of the stomachs that this observation was not significant. Details of the occurrences of the major food items are given in Table 7.

Asellus was the principal food organism in both waters, followed by gastropods, especially *Bithynia tentaculata.* Chironomid larvae and pupae, Trichoptera and Ephemeroptera were all frequent from Lough Derg stomachs, slightly less so from Parteen Neither *Gammarus* nor *Mysis* occurred in the Lough Derg eels. Six *Gammarus* were found in a 57 cm eel from Parteen.

The full list of 32 organisms (Table 8) from Lough Derg included no fewer than 11 species of Trichoptera of which two were Polycentropids and six Leptocerids. Ephemeroptera were few, the majority being *Ephemera danica.* Chironomids were frequent and usually occurred in large numbers, up to 188, mean 21.6. *Bithynia tentaculata* was identified in 32 stomachs and probably was the species represented in many of the 14 records of crushed gastropod shells. *Lymnaea peregra* was identified in only eight cases. Two unusual food items were an Anisopteran nymph, taken by a 52 cm eel and six specimens of the uncommon Hemipteran *Aphelocheirus montandoni* in a 47 cm individual.

The list of food organisms from Parteen Reservoir was much shorter numbering only twelve. Forms not found in Lough Derg were *Gammarus* sp., a small adult Colepoteran and one Ephemeropteran, *Baetis pumilus.*

Organisms identified with less certainty than those listed included:

Ephemeroptera	...	3
Trichoptera larvae	...	12
Lymnaea sp.	...	2
Gastropoda	...	14

LOUGH KEY AND WATERS UPSTREAM OF LOUGH DERG 1970-71

In June 1970 small samples of eels were collected over a wide area of the Shannon and a major tributary, the Boyle River. A cabin cruiser was used as a base and the cruise extended from Lough Key to Portumna. The results established that eels were plentiful in all of the regions visited and it was decided to make a fuller study of the eels of Lough Key in the following months.

Lough Key lies on the Boyle River, 185 km from tidal water (Fig. 1). The underlying rock was Devonian and Lower Carboniferous but the immediate surroundings were largely drumlins which formed many islands and peninsulas in the lake. The maximum depth was 25 m and there was a substantial littoral region of shallow water. Oakport Lake was 3 km downstream of Lough Key on the Boyle River, on Carboniferous Limestone Lough Bofin lay on the main River Shannon 30 km downstream from Oakport Lake and about 150 km from the tidal boundary. The water in all of the sampling areas was rich.

The work in July and August was based in Lough Key Forest Park where the head forester, Mr. John Duane, kindly provided a site hut for shelter. The main sampling season extended from July 3 to August 5 and from August 26 to 29. Field work was done by zoology students Miss Ann Fortune and Miss Christine Royle. Subsequently, periodical samples were taken to determine the period of hibernation of the eels.

Catch and effort

The usual procedure was to fish in water of less than 3 m depth for one night. Occasionally spells of bad weather resulted in the nets being left down for two nights. A train of eight nets, described as the "set net", was set at the edge of a *Phragmites* bed to the west of Drummans Island in Lough Key (Fig. 3). It was lifted and emptied daily when possible. At the end of August three trains of eight nets were set daily, end to end and leading gradually from the shallows into deeper water off Church Island so that ground from 1.7 to 22 m deep was sampled. This experiment had to be discontinued on account of bad weather.

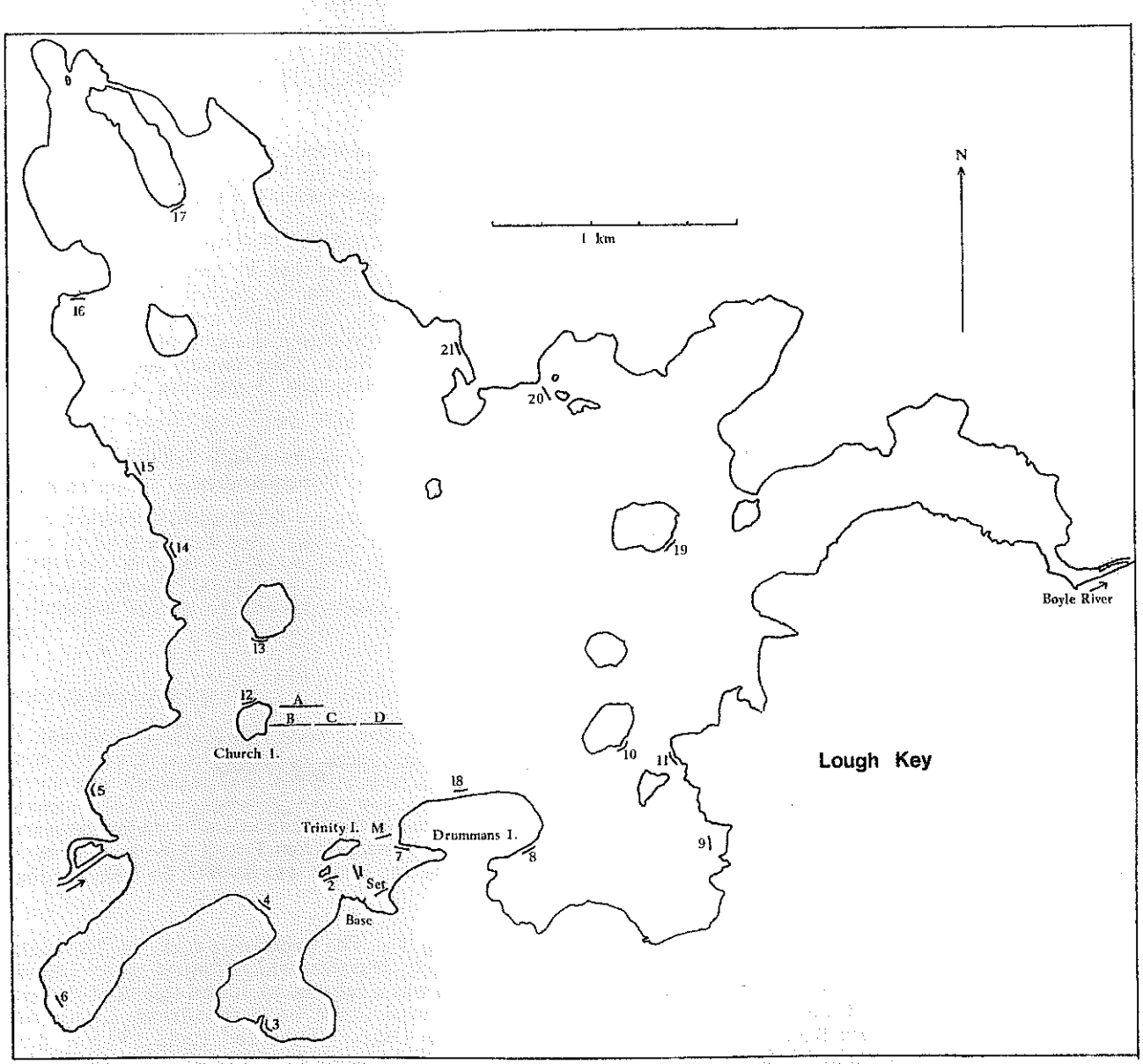

Fig. 3. Lough Key showing sampling positions. Based on the Ordnance Survey by permission of the Government (Permit No. 1833).

All the catches in the lakes in June were good, especially in Lough Key where a unit catch of 4.7 was made on one occasion in water of 2-3 depth. In 5 m depth in Lough Key the lowest catch per unit of effort in the lakes, 1.0, was made. The river catches were lower, a maximum of 1.9 at Portumna and minimum of 0.5 at Termonbarry, mean 1.2. In Lough Key in July the shallow water catch ranged from 0 to 5.2, mean 1.5 and was greater than 1.0 on 14 days out of the 24. Two very good catches, of 5.2 and 4.6 were made on July 8 and 9. In deeper water in Lough Key the catch varied from 0.1 to 1.8, mean 0.8 and was only twice greater than 1.0 in 12 trials. The total effort in this experiment was 96 net days, catch 75. Details of catch and effort are given in Table 2.

The fishing positions are shown in Fig. 3. The best catches were made at positions 5 and 6, both in bays sheltered from the prevailing south-west wind and with muddy beds. The three lowest catches (0 to 0.1) were made in slightly more exposed positions where the bed was stony (positions 7, 13 and 16). Good catches were made in the very exposed positions 20 and 21 where the bed was muddy. From this it seems that even in shallow water the nature of the bed was of greater importance than the degree of exposure.

The trials made in deeper water were unfortunately limited. The indications were that average catches were made down to 19 m, but the last train at 19 to 22 m showed a fall in numbers taken, from a mean of 0.8 in less than 19 m to 0.1 in the deepest part.

The "set net" at Drummans Island was fished daily from July 4 to August 5 and was set again at the end of the month, to be fished on August 27, 28 and 29. The daily routine was interrupted by bad weather on July 5, 9 and 10. The results are shown in Table 9.

Table 9. Catch per unit of effort and mean length of eels in train of eight nets in single position, Lough Key.

Date	Catch	Mean length (cm)
July 4	2.3	50.4
6	0.5	57.7
7	0.3	56.5
8	0.5	58.3
11	1.3	47.9
14	0.1	49.3
15	0.1	49.3
20	0.6	53.8
21	0.5	48.3
August 4	0.1	41.5
5	0.1	39.0
No fishing for 22 days		
August 27	0.3	45.0
28	0.1	50.0

The nets were empty on 19 of the 33 days of the experiment. While the catch on the first night was 2.3 per net, the next highest was 1.3 and all the others were much lower. The mean length of the eels taken in the first four days of the experiment (52.9) was significantly higher than the mean of those taken in the later period (46.6). At the end of April of the following year a catch of the same order as that for the first night in 1970 was made.

In November 1970 an experiment began in which nets were set in the vicinity of Drummans Island and left to fish for one week, such samples to be made once a month. One train of eight nets was set in the "set net" position and a second train was set between Drummans and Trinity Islands. No eels were caught in November and sampling was abandoned until February. Dates, water temperatures and catches are shown below:

1970	November 17—24	catch 0	temperature	6.5°C
1971	February 25—March 4	3		6.0
	March 30—April 6	5		10.0
	April 21—April 27	46		9.0

Apparently, activity in winter did not cease altogether but continued at a very low rate. Activity at the summer level had resumed by the end of April when the temperature was about 9°C. A slightly higher temperature at the beginning of April did not bring about the increase in activity—possibly a period of warm conditions is required to induce the eels to end their hibernation. The food invertebrates, especially *Asellus*, had been plentiful and active since the early March sampling.

Length, weight and age

No eels of less than 30 cm length were collected upstream of Lough Derg and specimens of less than 40 cm were scarce. They accounted for less than 10% of the catch in all cases except at Portumna. Four of the sample of fifteen eels there (27%) were small. Large specimens, of more than 60 cm, were plentiful in all of the lakes but scarce in the river between Lough Ree and Lough Derg where only one was found in a sample of 24. Details of the length distributions are given in Table 3. Chi-square tests showed that the proportion of eels of longer than 50 cm was significantly greater in the upstream lakes than in Lough Derg. No significant difference was observed between the lengths of the Lough Key eels and those of the other upstream lakes. The eels of the late August sample from Lough Key, from water of more than 3 m deep, were significantly smaller than those from the shallows in July (39% greater than 50 cm in deep, 57% in shallows).

Length/weight relationships were computed as described in Moriarty (1972) for specimens of more than 40 cm and showed a relatively high condition index, from 3.0 to 3.4. In the Lough Key samples, the index for June was considerably lower than that for July but the variation in weight for lengths was so great that the significance of the observation is uncertain. It may be said in general that the eels of the lakes and river were typically fat, sharp-nosed individuals. Figures for the regression equation are shown below:

	a	b	*n*	s
Lough Key (June)	0.0027	3.02	31	0.06
Lough Key (July)	0.0004	3.38	96	0.06
Oakport Lough	0.0004	3.37	22	0.04
Lough Ree	0.0007	3.43	12	0.10

Regrettably, no age determinations for the June samples were made since most of the otoliths were lost overboard. In Lough Key 58% of the otoliths were clear. The modal age group was 11-12 and 55% of the July sample were older than this. Large eels, up to 70 cm, were found down to the 9-10 year group. Small specimens, down to 46 cm were found to be as old as 18. Eels of 13 to 16 years were plentiful at 43% but the numbers in higher age groups were small. Fishing for yellow eels was forbidden on Lough Key, as on other lakes on the Shannon system, so it may be assumed that the disappearance of older eels was caused mainly by spawning migration. Details of age and length are given in Table 4. The percentage age distribution of the August sample is given in parentheses.

Food

Figures for the fullness of the stomachs are given in Table 5. No significant differences were observed between the rates of feeding of the various size groups. In Lough Key a chi-square test showed that significantly greater numbers of the June eels (85%) contained food than did those caught in July (65%). No differences were observed between the July and August Lough Key samples nor were any seen between the various waters sampled in June.

The dominant food in the 44 full stomachs is shown in Table 6. *Asellus* was the most frequent, filling 15 stomachs. The next in frequency was *Anodonta* in 13 stomachs. On account of the relative sizes of individual organisms, *Anodonta* was usually found to fill stomachs which contained it while *Asellus* occurred much more frequently without filling the stomach. Gastropoda, usually *Bithynia tentaculata,* filled 9 stomachs; Ephemeroptera, Trichoptera and fish two stomachs each and a variety of invertebrates filled one.

Asellus and Gastropoda were the most frequently occurring organisms, *Bithynia tentaculata* being the usual snail with a lower frequency of *Lymnaea peregra.* In the lakes in June Trichoptera came second in frequency to *Asellus* except in Lough Bofin where they were the most frequent. In July in Lough Key Trichoptera came third and had dropped to a position of minor importance in August. Presumably emergence of the adults throughout the summer led to the replacement of large larvae by the individuals of the next generation which were too small to be attractive to the eels. Ephemeroptera, notably *Ephemera danica,* were important food organisms in Lough Key. As mentioned above, *Anodonta* where it occurred was always a major constituent of the stomach contents. *Gammarus* was very scarce, Chironomids of relatively little importance and fish of rather less. *Mysis* was not found in the shallow water but assumed considerable importance at depths greater than 15 m. Details of the frequency of occurrence of the food organisms are given in Table 7. No significant differences were observed in the relative importance of any with regard to size of the eels.

In June 37 forms of food organisms were identified from 88 stomachs taking all of the lakes and river together. In July and August 60 forms were identified from 189 stomachs from Lough Key. The full list is given in Table 10; in addition to those listed in the Table the following were identified:

	June	July/August
Ephemeroptera	2	4
Coleoptera adult	1	2
Coleoptera larvae	1	5
Corixidae		5
Limnephilus larvae	4	
Other Trichoptera larvae		10
Trichoptera pupae	1	3

making in all at least 67 species of organisms.

Larval Trichoptera, numbering 21 species played a more important part than had been observed in the other river systems investigated to date (Moriarty 1972, 1973). In particular, some small species of *Limnephilus* were very frequent and *Molanna angustata* appeared in 28 stomachs. One or more species of *Phryganea* were also important. The Leptocerids and net-spinning larvae were less plentiful than expected. The scarcity of Chironomid larvae has already been mentioned. The most frequent constituent of the stomachs was *Asellus aquaticus* which was present in 188 stomachs with a mean of 44.4 individuals per stomach. The only other organisms found in more than 25% of the stomachs were *Bithynia tentaculata* which occurred in 32% and *Ephemera danica* in 27%.

Large numbers of *Bithynia,* up to 113, were found in some stomachs, these being small immature individuals. While *Asellus aquaticus* appeared 188 times, *A. meridianus* was seen only once. Perch were found twice and pike once. Cyprinid eggs were not seen in the stomachs, in spite of the abundance of bream and rudd in the lake.

The stomach contents of all Lough Key eels taken in July were weighted as described on p.3). Mean weights (grams) of the contents are shown below.

length (cm)	All stomachs Number	All stomachs Mean weight	Full stomachs Number	Full stomachs Mean weight	Full stomachs Max. weight	Contents of heaviest.
30—40	15	0.27	1	0.90	0.90	*Lymnaea peregra*
40—50	87	0.39	5	2.61	3.93	*Anodonta*
50—60	64	0.78	5	3.97	7.15	*Asellus*
60—80	38	1.42	5	6.28	14.23	*Asellus*

LAKES OF THE FERGUS SYSTEM 1968 AND 1973

The River Fergus is a major tributary of the Shannon, entering the estuary of the latter some 75 km from the open sea. In 1968 two lakes, Inchiquin and George, close to Corofin were sampled (Fig. 4). In the winter of 1972 an experimental fishery for silver eels on the river entering the Fergus Estuary north of Clenagh Castle (H 362 658) was established. As part of the investigation two lakes which were believed to lie on this river were sampled in 1973. Drainage in this region of Upper and Middle Carboniferous Limestone was underground in many places and the courses of the streams draining the lakes could not be established with certainty. Periodically an overground stream ran from Lough Gash to the silver eel trap but other outlets from it could have existed (Fig. 4).

The River Fergus flowed through Inchiquin Lake (105 ha) reaching tidal water some 16 km downstream, having passed through three rather smaller lakes. The maximum depth was over 25 m but there was a substantial littoral zone where the water was less than 3 m and weed growth was plentiful. Lough George (61 ha) lies on a tributary of the Fergus and was separated from the main river by three lakes and from the sea by two more. Its outlet was 23 km from tidal water. No information on depth or water chemistry was available but the region of shallow water was found to be narrow and the lake plunged rapidly to a depth of over 15 m. The water was clearly rich in lime and likely to have had a similar chemical composition to that of Inchiquin (Table 1).

Fin Lough (220 ha) was less than three metres deep over most of its area and six metres was the greatest depth found. The water was clear and the bottom thickly coated with vegetation, especially *Chara*. Fin Lough lay about 10 km from the estuary and was supposed to drain through the nearby Ballycar Lake and thence through Lough Gash. The alkalinity was high at 1.7 m eq/l. Lough Gash (37 ha) was clearly a very rich lake and, like Fin Lough, less than 3 m deep over most of its area. Much of its bottom was carpeted by *Chara* but there was much bare mud with sparse *Potamogeton* growth.

Field work in Inchiquin Lake was by Mr. Padraig de Bhaldraithe and in Lough George by Miss Mary Canning, zoology students. In Lough Gash and Fin Lough Miss Maria Cramp and Miss Maura Leahy, zoology students, assisted with the field work and invaluable voluntary help was provided by Mr. Michael Shinners and Mr. Sean O'Leary of Newmarket-on-Fergus

Catch and effort

Sampling on Inchiquin took place from July 11 to August 9 and fishing took place to a depth of 5 m on all sides of the lake. In Lough George sampling lasted from August 13 to September 13 but frequent bad weather curtailed the daily fishing effort. Fishing took place in water of less than 3 m depth except on three occasions. In each case single trains of eight nets were used. Catch per unit of effort was 2.3 in Inchiquin and 0.3 in George in the shallows (Table 2). The difference between the catches made in Inchiquin Lake between depths of 1 to 3 m and 3 to 5 m was highly significant. An effort of 72 net days in the shallows yielded 164 eels while in the slightly deeper water an effort of 160 net days yielded only 112 eels, a catch per unit of effort of only 0.7. In Lough George no eels were caught on one occasion when the nets were set at 15 m.

In Fin Lough a short season of two nights, July 26 and 27, with five trains of eight nets each night gave a total effort of 80 net days. In Lough Gash two trains of eight nets on the night of July 28 yielded 73 eels, substantially more than the 54 caught by the much greater effort in Fin Lough. In each case the effect of the downstream lakes serving to inhibit further upstream migration was apparent.

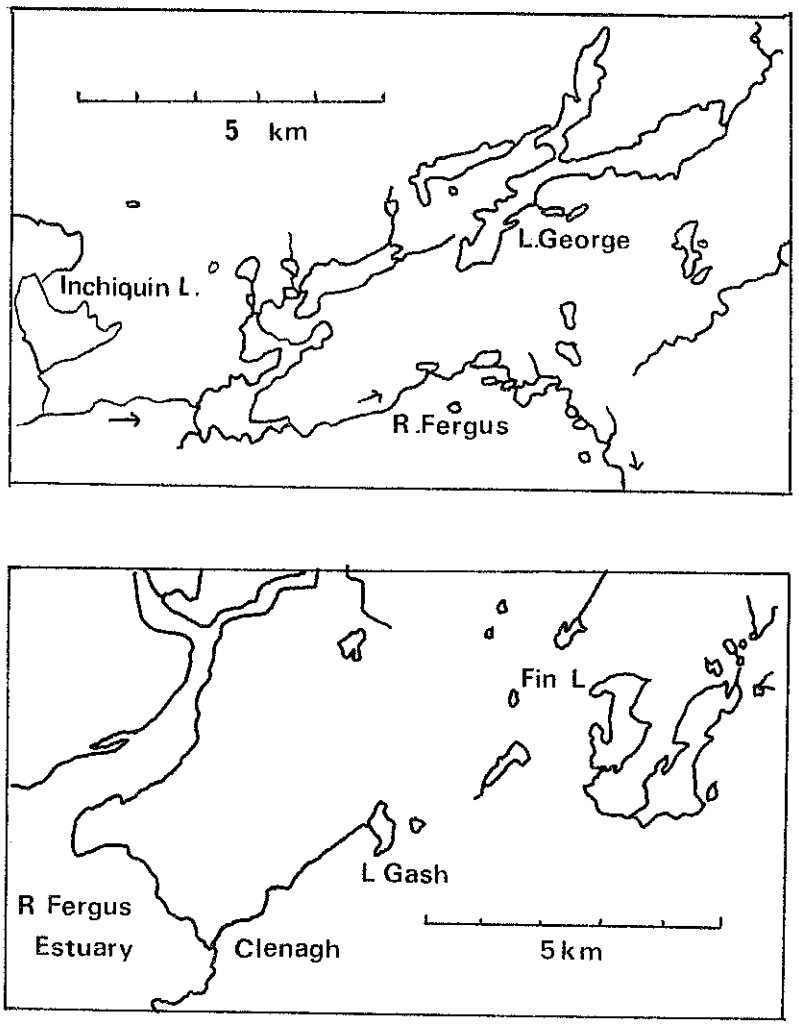

Figure 4. Fergus System lakes. Based on the Ordnance Survey by permission of the Government (Permit No. 1833).

Length, weight and age

The length distributions shown in Table 3 are for eels caught after one night's fishing in water of less than 3 m in Inchiquin Lake. The numbers of eels caught after single nights in Lough George (33) was so small that it was considered preferable to include all of the sample in the table. Large eels were so scarce there that no effect of the longer fishing periods' reducing the proportion in the catch could be discerned. In Inchiquin Lake a highly significant difference was observed between the numbers of large and small eels (Chi square 16.2 for 2 degrees of freedom). In the shallows 14% of the catch were longer than 50 cm while in the deeper water only 4% of large eels were taken. Only one eel longer than 60 cm was caught in deep water compared with 18 from the shallows. The Lough George eels were very much smaller than those from Inchiquin Lake and indeed from any lake studied in the programme. Only one specimen of over 60 cm was collected and only 36% of the sample were more than 40 cm.

The Fin Lough eels, although not numerous, were fairly large, 10% being over 50 cm and 70% over 40 cm. No specimens of more than 60 cm were taken. The eels of Lough Gash were bigger and more plentiful, 26% being over 50 cm and 5% over 60 cm.

Eels from Inchiquin and Lough George were not weighed. Those from Fin Lough and Lough Gash had high values for the condition index *b*, of 3.0 in Fin Lough and 3.5 in Lough Gash.

Details of the age distribution are given in Table 4a. The eels of Inchiquin Lake showed great variations in growth rate, from an 11 year old specimen measuring 92.5 cm to a 15 year old which measured only 34 cm. The mean growth rate was relatively high and 31% of the sample were older than 12 years. Old eels were also plentiful in Lough George, 24% over 12 years, but the growth rate was lower.

Eels of more than 12 years were very scarce in Fin Lough, perhaps as a result of long-line fishing. The calculated rate of increase in length of only 0.7 cm per year probably reflected the scarcity of large eels rather than an exceptionally slow growth rate. The eels of Lough Gash were fast-growing and apparently early-maturing. The presence of substantial numbers of specimens of more than 50 cm suggested that the stock had not been exploited for some years.

Food

No significant differences in the fullness of the stomachs on a basis of size were observed. Rather high proportions of empty stomachs (55 and 45%) were observed in Inchiquin Lake and Lough George; the figures of 31% and 24% for Fin Lough and Lough Gash were closer to typical Irish results. In Lough Gash full stomachs were found in 39% of the sample, a high proportion for a lake eel population (Table 5).

The dominant food in full stomachs from Inchiquin Lake was variable, including *Asellus*, Ephemeroptera, Chironomid larvae, *Sphaerium* and fish. *Asellus* was the principal constituent of the only full stomach from Lough George and in Lough Gash Chironomids, fish and the Trichopteran *Limnephilus decipiens* were found (Table 6).

On the basis of the frequency of occurrence of organisms in the stomachs (Table 7) a distinct preference for fish and gastropods was shown by eels of more than 50 cm in Inchiquin Lake, no invertebrates other than gastropods were found in these larger eels. Large eels were too scarce in the Lough George and Fin Lough samples to allow for comparisons. In Lough Gash invertebrates were very few in the stomachs of large eels while fish were plentiful. Chironomids, Gastropods and *Asellus* were the principal invertebrate groups.

At least 48 species of organisms from the stomachs were identified. At one extreme, 32 different organisms were found in the 36 Fin Lough stomachs which were examined. At the other, the 76 Inchiquin stomachs contained only 19 different species. Chironomid larvae were identified to genera from Lough Gash and Fin Lough. Identification of Chironomid larvae to genera might have increased the number of Inchiquin Lake food organisms to 25. Even this figure is well below the numbers found in the other lakes. In Lough George, where food appeared to be rather scarce, a number of families of Dipterous larvae were found which rarely occurred in eels from richer waters.

Chironomid larvae were identified to genera or at least to sub-families for the first time in the investigation, using the key work of Mason (1968). In both Fin Lough and Lough Gash the rather large individuals of *Chironamous* (*Chironomous*) were the most frequent, most of them measuring more than 10 mm in length. Five other genera were recorded in small numbers (see Table 11). Trichoptera and Ephemeroptera seldom assumed any importance. *Bithynia, Valvata,* and *Lymnaea peregra* were all plentiful. The relatively high mean of 5.6 *L. peregra* per stomach reflected rather large numbers of very small (less than 3 mm high) individuals. *Bithynia tentaculata* accounted for a greater quantity of food than did *Lymnaea*. *Sphaerium* sp. was an important item in the diet of the Inchiquin Lake eels.

SHANNON ESTUARY 1971 AND 1972

The Shannon Estuary, a region of strong tides and extensive mudflats, was the largest area of water in the country which had not previously been sampled by fyke netting. Samples were collected from August 17 to 20 1971 with the assistance of Mr. Daniel O'Farrell who subsequently fished the area commercially with considerable success. These samples were taken from two regions; the first centred on Battle Island, 13 km downstream of Limerick, with salinity at low tide of 2.9‰; the second was from 10 km upstream of Battle Island at Ballinacuragh where the salinity was 0.7. On September 5 and 6, 1972, trains of eight nets were fished off Scattery Island, about 25 km from the open sea (Fig. 1). Salinity was not determined but must have been relatively high since the by-catch included *Conger* and *Scyliorhinus*. Samples were taken by Mr. B. Doolin of Fisheries Division and Miss Maria Cramp and Miss Una Nic Fhionnlaoich.

Catch and effort

Substantial catches (Table 2) were made in the water of low salinity at Battle Island and Ballinacuragh. At Scattery strong tides led to loss or tangling of some of the nets but two trains fished successfully. One eel was caught in these 16 nets. 15 *Conger* were also caught, showing that the nets were functioning normally.

The accumulation of shore crabs *Carcinus maenas*, seaweed and other foreign matter blocked the openings to the nets in tidal water. They cannot therefore have operated as efficiently as those in still fresh water. In spite of this, the catches per unit of effort were very much higher in parts of the estuary than in any of the freshwater areas studied.

Length, weight and age

The single eel from Scattery Island measured 55 cm, weighed 300 g and was aged 13 years. Length distributions are shown in Table 3. Eels from the upstream Ballinacuragh position gave the expected positive skew but the sample from Battle Island had an approximately normal length distribution, indicating a scarcity of small individuals. The index in the length/weight regression was very low: 2.6 for Battle Island and 2.2 for Ballinacuragh, indicating exceptionally thin eels.

Ages were determined for 21 eels from Battle Island. The rate of increase in length (determined as in Moriarty 1972) was similar to that from the Shannon freshwater population. The ages ranged from 8 to 17 and the youngest specimens of more than 60 cm was 13 years old. (See Table 4).

Food

The stomachs of 23 specimens from Battle Island were examined. Food was present in 78% and 26% were full. Only one full stomach was found in eels of over 40 cm, this contained a sole *Solea vulgaris* of 22 g. Two full stomachs contained mixed food: the first had two *Crangon vulgaris* and four unidentified crustaceans of 40-50 mm length. The second held one Mysid, one fish, one Gammarid and one crab of 5 mm carapace breadth. The remaining three contained from three to five *Crangon* measuring 30 to 40 mm. Gammarids, Mysids and crabs occurred in two stomachs each: one of the crabs was a specimen of *Carcinus maenas* with carapace 14 mm across. *Praunus* was found in one stomach and the unidentified crustaceans were probably *Crangon*. The list of food organisms is given in Table 12.

MIGRATION OF ELVERS AND SMALL EELS

Preliminary studies of migrating eels were made in 1970 and 1973. Elvers were captured at the dam at Ardnacrusha at the head of the tide. Small eels which had passed the dam, travelling by the main river, were taken at Parteen Weir (Figure 2). On May 27, 1970 a small sample of the eels at Parteen was collected for age determination. In 1973 samples of the eels at Parteen were collected and measured once a month and samples of elvers from Ardnacrusha were measured when possible. This work will be increased in scope in the next few years but it is felt that the preliminary results should be published at this stage.

The ages of the eels migrating upstream at Parteen ranged from two years to nine. The age distribution is given below. Ages were very much higher and more varied than had been expected.

Age in years	2	3	4	5	6	7	8	9	total
Percentage	9	22	4	35	22	4	0	4	23

Elver and young eel measurements at Parteen Weir which was 15 km upstream of tidal water are given below. Measurements of elvers captured at Ardnacrusha on August 17 are included.

A. Parteen elver trap, 1973.

Length (cm)	6.9—7	8—9	10—14	15—19	20—24	25—29	*n*	mean	SE
Date									
June 15	3	43	40	10	3	1	1,385	10.9	0.10
July 27	1	12	64	18	5	0	198	12.8	0.24
August 17	1	22	39	21	10	7	209	14.2	0.40
September 25	1	4	22	32	25	16	130	18.3	0.50
October 26	0	1	18	45	31	5	233	18.1	0.24

B. Tidal boundry at Ardnacrusha, August 17, 1973.

Length (mm)	60—62	63—6	66—68	69—71	72—74	75—77	78—80	*n*	mean	SE
	2	2	15	33	31	13	4	52	71	0.04

The increase in the mean lengths at Parteen could be explained by growth during the year or by a tendency for older individuals to migrate later. The very small numbers of specimens of less than 80 mm at Parteen suggests that no elvers of the year succeeded in travelling that far from the sea.

SUMMARY

1. This paper is the third in a series on the biology of immature eels in Irish waters and gives the results of the examination of fyke-net samples from Lough Derg, Lough Key and a number of smaller lakes on the main River Shannon and a tributary, the Fergus. Samples were also taken from the Shannon estuary. The catch per unit of effort in most of the lakes was within the range of 1.0 to 2.0 recorded elsewhere in Ireland. Substantially greater populations were recorded from Inchiquin Lake and Lough Gash and low populations from Lough George and Lough Fin. Catches in the upper Shannon estuary were very high, from 6.5 to 9.2 but *Anguilla* eels were virtually absent from the lower reaches, sampled at Scattery Island. *Conger* was plentiful there.

2. In general, the eels of the main Shannon system were found to be large specimens. The growth rate was similar to that recorded from the Corrib system and many other lakes in Ireland but the age of maturing was greater by three or four years, specimens of 13-14 years being plentiful (usually over 20% of the samples) while older specimens were common. An exception was found in Lough George where eels were both scarce and small, the small size resulting from slow growth. The estuarine eels grew in length at a similar rate to those in the main Shannon but they were broadheaded and had a much lower condition factor.

3. Most of the eels of Lough Gash and Inchiquin Lake adopted a diet of fish when a length of 50 cm had been reached. In the other lakes the diet of eels of all sizes was principally invertebrate, fish being remarkably few in the stomachs. The water louse *Asellus* and the snail *Bithynia* were amongst the dominant food organisms, the freshwater mussel *Anodonta* and the mayfly *Ephemera danica* were other important items. The estuarine eels fed mainly on crustaceans, especially *Crangon* shrimps.

4. Preliminary studies of elvers and ascending eels were made in the Shannon. Elvers continued to enter the freshwater at Ardnacrusha as late as August. At Parteen Weir, 15 km upstream of tidal water, few, if any, elvers of the year were captured from May to October when the ascent ended.

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REFERENCES

Anon. (1907). *Rep. Sea inld. Fish. Ire.* 1906, p.154.

———— (1908). Ibid. 1907, p. 152.

———— (1974). Ibid, 1972, p. 61.

Flanagan, P. J. and Toner, P. F. (1972). *A report on water quality.* An Foras Forbartha, Dublin.

Mason, W. T. (1968). *An introduction to the identification of chironomid larvae.* U.S. Department of the Interiorr, Cincinnati.

Moriarty, C. (1972). Studies of the eel *Anguilla anguilla* in Ireland. 1, In the lakes of the Corrib System. *Irish Fish. Invest.* Ser. A. 10, 1-39.

———— (1973). Studies of the eel *Anguilla anguilla* in Ireland, 2. In Lough Conn, Lough Gill and North Cavan lakes. Ibid. Ser. A. 13, 1-13.

TABLES

Table 1. Location and chemical analyses of waters in study.

	Alkalinity mEq per 1	Conductivity recip. megohm per cm	Distance from tidal boundry (km)	Grid Reference	Area ha
Parteen			15	R 68 68	300
Derg	3.4—3.8		20	R 80 90	11,714
Key	2.8	281	185	G 82 03	895
Inchiquin	3.7	400	16	R 27 90	105
George			23	R 33 91	61
Gash			4	R 39 67	37
Fin	1.7		11	R 42 68	220
		Salinity ‰			
Ballinacuragh		0.7	5	R 54 56	
Battle Island		2.9	15	R 46 57	

Table 2. Catch, effort and mean weight of eels, based on single night's catches in water of less than 4 m.

Position	Date	Effort (net days)	Catch per net per day	Total catch	Mean weight (g)
Shannon Lakes					
	1969				
Parteen	Aug. 8—14	49	1.1	57	153
Derg	July 16— Aug. 7	189	1.6	300	194
	1970				
Key	June 13—14	32	3.5	72	
Oakport	June 16	8	2.7	22	
Bofin	June 17	8	1.2	10	
Ree (Blackbrink)	June 18	16	1.5	24	
Key	July 3 — Aug. 5	208	1.5	303	216
Fergus Lakes					
	1968				
Inchiquin	July 11 — Aug. 9	72	2.3	164	
George	Aug. 13 — Sep. 13	224	0.3	76	
	1973				
Fin	July 27—28	80	0.7	54	168
Gash	July 29	16	4.6	73	216
Shannon River					
	1969				
Killaloe	July 16	7	2.5	18	195
	1970				
Termonbarry	June 12	8	0.5	4	
Clonmacnoise	June 13	8	1.1	9	
Portumna	June 15	8	1.9	15	
Shannon Estuary					
	1971				
Battle Island	August 18—19	35	6.5	226	236
Ballinacuragh	August 20	14	9.2	129	
Scattery Island	September 5—6	16	0.06	1	300

Table 3. Length distributions (in cm to nearest whole number downwards, percentage of *n*).

Position	25—34	35—39	40—44	45—49	50—59	60—69	70—91	*n*	$\bar{x}$	SE
Shannon Lakes										
Parteen	2	18	39	26	12	3	0	57	45.0	0.83
Derg	1	11	27	27	29	4	1	271	47.4	0.76
Key, etc. June		5	12	18	39	20	6	81	54.1	1.06
Key, July	1	6	18	21	31	18	5	365	52.5	0.70
Fergus Lakee										
Inchiquin	9	46	23	8	6	1	7	139	43.3	1.07
George	27	37	19	9	7	0	1	76	39.7	0.92
Fin	0	30	40	20	10	0	0	49	43.2	0.65
Gash	4	19	21	28	21	4	1	71	46.2	1.04
Shannon Estuary										
Battle Island	6	13	13	14	25	22	7	244	51.4	0.94
Ballinacuragh	16	23	14	16	23	7	1	129	44.5	0.87

Table 4. Length and age dtaa. Figures in parentheses under Lough Key refer to August sample.

Position	Numbers	Age	%	Length (cm) Minimum	Maximum	Mean	SE	% of clear otoliths
Shannon Lakes								
Parteen	27	7— 8	30	38	47	42.9	1.1	55
		9—10	33	37	49	43.0	1.4	
		11—12	22	42	51	48.1	1.3	
		13—14	11	44	53	49.6	2.8	
		15—16	4	54				
Derg	259	5— 6	1	36				38
		7— 8	8	33	50	41.5	0.82	
		9—10	22	34	55	43.8	0.65	
		11—12	32	35	64	46.4	0.62	
		13—14	22	36	61	49.1	0.68	
		15—16	10	39	70	52.7	1.41	
		17—18	4	50	76	56.7	2.29	
		19—21	1	56	75			
Key	256	7— 8	3 (9)	36	42	40.3	1.05	58
	(75)	9—10	12(19)	35	70	44.2	1.25	
		11—12	30(34)	37	71	48.9	0.77	
		13—14	26(15)	40	64	52.1	0.82	
		15—16	17(11)	42	72	56.4	1.15	
		17—18	9 (7)	46	72	63.7	1.35	
		19—25	3 (5)	56	78			
Shannon Estuary								
Battle Island	21	7— 8	24	35	44	39.8	1.87	43
		9—10	24	33	44	36.9	2.15	
		11—12	19	44	54	49.6	2.10	
		13—14	19	53	61	57.7	1.89	
		15—16	5	65				
		17—20	9	71	72			

Values in length/age regression $y=cx+d$:

	Numbers	c	d	r	s	length range (cm)
Parteen	20	1.8	27.4	0.91	3.4	37—54
Derg	33	3.1	12.0	0.8	6.7	33—76
Key	46	2.8	17.8	0.8	8.7	35—78
Battle Island	21	3.4	10.5	0.9	5.1	33—72

Table 4a. Length and age data (continued).

Position	Numbers	Age	%	Length (cm) Minimum	Maximum	Mean	SE	% of clear otoliths
Fergus Lakes								
Inchiquin	221	7— 8	13	31	47	37.0	0.77	29
		9—10	29	31	51	37.7	0.49	
		11—12	27	30	92	42.1	1.41	
		13—14	22	35	79	46.1	1.51	
		15—16	5	34	75	50.8	3.95	
		17—18	2	45	60	52.8	3.09	
		19—26	2	76	91			
George	75	7— 8	10	32	40	34.9	1.01	28
		9—10	37	28	41	34.7	0.57	
		11—12	21	32	45	37.6	1.06	
		13—14	13	35	56	41.6	2.04	
		15—16	8	39	57	46.8	2.50	
		17—18	3	42	43	42.5	0.50	
		19—25	8	46	83			
Fin	50	7— 8	12	37	48	41.2	1.91	40
		9—10	48	37	52	44.4	0.87	
		11—12	30	39	52	44.3	1.02	
		13—14	10	39	53	46.8	2.75	
Gash	66	5— 6	17	35	53	44.4	1.86	47
		7— 8	43	32	54	44.7	1.17	
		9—10	26	37	65	47.3	1.85	
		11—12	11	34	66	52.4	4.78	
		15—17	3	46	71			

Values in length/age regression $y=cx+d$:

	Numbers	c	d	r	s	length range (cm)
Inchiquin	48	3.1	16.2	0.7	12.8	30—91
George	28	2.0	15.8	0.8	6.6	28—83
Fin	25	0.7	36.8	0.3	4.2	37—53
Gash	32	2.2	27.9	0.5	8.4	32—71

Table 5. Fullness of stomachs of eels caught after single night's fishing (% of *n*).

	Empty		Partly filled	Full	*n*
	Hind-gut void	Hind-gut full			
Shannon Lakes					
Parteen	63	11	23	3	57
Derg	33	10	56	1	187
Key (June)	12	3	64	21	34
Oakport	0	14	54	32	22
Bofin	20	10	70	0	10
Ree	8	15	41	36	13
Key (July)	20	15	57	8	210
Fergus Lakes					
Inchiquin	55		39	6	150
George	45		52	3	31
Fin	14	17	44	25	52
Gash	6	18	37	39	72
River Shannon					
Portumna and Clonmacnoise	4	4	80	12	25
Shannon Estuary					
Battle Island	4	18	52	26	23

Table 6. Dominant food in full stomachs.

	Asellus	Ephemeroptera	Trichoptera	Chironomidae	Gastropoda	*Anodonta*	Fish	Others	Number of stomachs with food
Shannon Lakes									
Parteen					1		1		15
Derg	1				1		1		105
Key etc. (June)	6		2		3	8	1	Invertebrates 1	88
Key (July)	9	2			6	5	1		189
Fergus Lakes									
Inchiquin	2	1		2			2	*Sphaerium* 3	76
George	1						1		17
Fin									36
Gash			1	3			2		
River Shannon									
Portumna and Clonmacnoise	2					1			23
Shannon Estuary								*Crangon* 5	
Battle Island								Crustaceans and fish 1	18

Table 7. Occurrences if major food items (% of n where n = number of stomachs containing food. Figures for Inchiquin Lake are given for large and small eels).

		Mysis	*Asellus*	*Gammarus*	Ephemeroptera	Trichoptera	Chironomidae	Gastropoda	*Anodonta*	Fish	n
Shannon Lakes											
Parteen	...		40	7	7	13	20	33		7	15
Derg	...		82		12	44	32	49		4	105
Key (June)	...		83	14	28	52		41	45	7	29
Oakport	...		79	5	26	68		63	21	5	19
Bofin	...		57	14	14	71		28	57		7
Ree	...		80		20	60	30	50		10	10
Key (July)	...		52	1	44	48	15	59	6	7	140
Key (August)	...	4	47	4	43	10	20	33	18	2	49
Fergus Lakes											
Inchiquin (30—49)	...		28	8	14	29	51	58		3	65
Inchiquin (50—91)	...							82		36	11
George	...		14	9			27	50		5	22
Fin	...		42	17	22	36	58	64			36
Gash	...		35	6		6	47	47		41	17
River Shannon											
Portumna	...		93			60	20	20	53		15
Clonmacnoise	...		85		14	14	14	28	28		7

Table 8. Food organisms, Lough Derg and Parteen. Figures in parentheses under "Range" indicate where range in Parteen exceeded that in Lough Derg.

	Numbers of stomachs containing organisms		Individuals per stomach	
	Lough Derg	Parteen	Range	Mean
Oligochaeta	1		2	2
Asellus aquaticus	85	6	1—148	25.5
Gammarus sp.		1	(6)	6
Anisoptera nymph	1		1	1
Zygoptera nymph	6		1	1
Ephemera danica	10		1— 7	2
Baetis pumilus		1	(1)	1
Aphelocheirus montandoni	1		6	6
Corixid	6	1	1— 3	1.6
Haliplid larva	2		1	1
Polycentropus flavomaculatus	6		1	1
Holocentropus dubius	5	1	1—	1.8
Tinodes waeneri	2		1— 10	5.5
Athripsodes cinerea	7	1	1— 4	1.7
A. fulvus	1		2	2
A. senilis	4		1	1
Mystacides azurea	1		1	1
M. longicornis	8		1— 5	1.7
Ocetis ochracea	1		2	2
Limnephilus lunatus	2		1	1
Lepidostomum hirtum	8		1— 5	2.1
Chironomid larva	31	2	1—188	6.1
Chironomid pupa	11	2	1— 13	
Bithynia tentaculata	32	1	1— 27(83)	6.1
Valvata piscinalis	1		1	1
Lymnaea peregra	8	2	1— 2	1.1
Planorbis carinatus	1		1	1
P. albus	6		1	1
Sphaerium	16		1— 8	1.9
Pisidium	4		1	1
Eel	1	2	1	1
Perch	1		1	1
Stickleback	1		1	1
Fish	1		1	1
Total food items	32	12	34	
Total stomachs with food	105	15	120	

Table 10. Food organisms, waters upstream of Lough Derg.

	Numbers of stomachs containing organisims Lough Key				Individuals per stomach	
	June		July	August	Range	Mean
	Lakes	River				
Oligochaeta			1		1	1
Piscicola geometra			1		1	1
Glossiphonia heteroclita			1	1	1	1
Helobdella sp.			1		1	1
Asellus aquaticus	57	16	90	25	1—616	44.4
A. meridianus			1		1	1
Gammarus lacustris	3				1— 2	1.5
G. duebeni	1		2		1— 2	1.5
Mysis relicta				2	27— 49	38.0
Anisoptera nymph			1		2	2
Zygoptera nymph	8		4		1— 2	1.2
Corixa semistriata			1		2	2
Sigara dorsalis			2		1— 2	1.2
Arctocoriza germari			2		1— 2	1.5
Ephemera danica	12		45	20	1— 20	3.5
Ephemerella ignita	1		3	1	1— 25	7.5
Caenis horaria	1		6		1— 17	7.1
Heptagenia sp.			1		2	2
Baetis sp.			1		1	1
Sisyra larva			1		1	1
Haliplid larva		3	5	4	1— 3	1.2
Gyrinus larva		1	1	1	1— 2	1.3
Nymphula larva			3		1— 5	2.6
Polycentropus flavomaculatus	1	4	9		1— 14	2.1
P. kingi			1		1	1
Holocentropus sp.			1		1	1
Cyrnus flavidus	8		3		1— 6	2.0
C. trimaculatus			3		1	1
Ecnomus sp.			1		1	1
Hydropsyche sp.	1				1	1
Phryganea sp.	11		11	1	1— 20	2.4
Limnephilus decipiens	15	3	11		1— 9	3.0
L. flavicornis			2		1	1
L. lunatus	1				1	1
L. vittatus	11	1	6		1— 31	6.3
Anabolia nervosa			3	1	1— 2	1.2
Athripsodes aterrimus			1		1	1
A. cinerea	1		10		1— 3	1.3
A. fulvus	1				1	1
A. senilis				1	1	1
Mystacides azurea	3			1	1— 6	2.8
M. longicornis	18		1		1—	
Ocetis ochracea	5	2	1		1— 4	3.1
Molanna angustata	6		22		1— 16	3.8
Chironomid larva	3	4	15	10	1— 12	2.9
Chironomid pupa			6	2	1— 7	2.3
Simulium larva			1		2	2
Dicranota larva			1		1	1
Limnophora larva			1		2	2
Theodoxus fluviatillis	1		1		1	1
Bithynia tentaculata	23	6	53	10	1—113	12.8
Valvata piscinalis	6	1	18		1— 12	2.2
Potamopyrgus jenkinsi	9		13		1— 50	4.6
Physa fontinalis			1		1	1
Lymnaea stagnalis	3	1			1— 9	3.2
Lymnaea peregra	10	3	12	5	1— 23	2.8
Planorbis carinatus	3		3		1— 2	1.2
P. albus	2		3		1— 2	1.2
Anodonta	21	11	8	9	1— 2	1
Sphaerium	1		10	1	1— 20	4.6
Pisidium	7	3	23	1	1— 7	1.7
Pike				1	1	1
Perch	1	1		1	1	1
Fish	3		10		1	1
Total food items	35	16	55	17	65	
Total stomachs with food	65	23	140	49	277	

Table 11. Food organisms, Fergus System lakes.

	Numbers of stomachs containing organisims				Individuals per stomach	
	Inchiquin	George	Fin	Gash	Range	Mean
Cladocera		3		1	2— 5	3
Asellus aquaticus		1	3		2— 29	11
A. meridianus		1	13	5	1—450	54.8
Asellus sp.	20				1—175	33.4
Gammarus duebeni	5	2	6	1	1— 25	6.1
Gammarus sp.	5				1— 6	3
Anisoptera nymph			1		4	4
Zygoptera nymph			3		1— 3	1.7
Caenis moesta			5		1— 15	3.8
Caenis sp.	8				1— 48	7.7
Heptagenia sp.	1				1	1
Cloëon simile			3		1— 15	7.6
Dytiscid larva				1	1	1
Gyrinus larva		1			1	1
Haliplid larva	2	5			1— 8	3.7
Chrysomelid larva			1		1	1
Sigara distincta			1		1	1
Callicorixa praeusta				1	1	1
Corixid adult			3		1— 4	2
Corixid nymph			2		1	1
Polycentropus flavomaculatus			1		1	1
Cyrnus flavidus			7		1— 7	3
Holocentropus picicornis			1		1	1
Phryganea sp.			1		1	1
Limnephilus decipiens				1	23	23
Limnephilidae larva			2		1	1
Athripsodes fulvus	1				1	1
Mystacides agurea	1				1	1
M. longicornis	12		3		1— 3	1.5
Ocetis ochracea	6		6		1— 5	1.8
Tanypus				1	1	1
Procladius			2	1	1— 8	4.3
Ablabesmyia				2	1— 4	2.5
Chironomus (*Chironomus*)			12	7	1—347	38.2
Glyptotendipes			1		1	1
Polypedilum			3		3	3
Chironomid larva (total)	30	6	20	8	1—347	23.8
Chironomid pupa	9	3	9	7	1— 62	8.2
Muscid larva		1			1	1
Tabanid larva		1			1	1
Chaoborus larva		1			1	1
Bithynia tentaculata	22	6	4		1— 14	3.7
Valvata piscinalis	24	5	5	1	1— 11	3.6
Lymnaea peregra	12	5	20	5	1— 56	5.6
Planorbis carinatus			1		2	2
P. albus	8		1		1— 4	2
P. contortus	1		4	1	1	1
Sphaerium	16		1		1— 20	8.2
Pisidium			5		1— 2	1.1
Bivalves	1				26	26
Eel	1				1	1
Pike			1		1	1
Fish	3	1		6	1	1
Total food items	19	15	32	15	48	
Tolal stomachs with food	76	17	36	17	146	

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